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Do Rivals Enhance your Credit Conditions?*

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Abstract

In a model where firms rely on bank financing to build capacity, put up specialized productive assets as collateral, and then compete à la Cournot, we introduce a probability of default. We investigate how the number of competitors affects the equilibrium amount of bank credit and derive conditions under which an inverted U-shaped relationship occurs. On one hand, more competitors enhance the resale value of collateralized productive assets. On the other hand, more competitors shrink firms' profits and the resulting income that can be pledged to banks. We then extend the analysis to firms outside the Cournot industry that are willing to buy productive assets in liquidation and show that the equilibrium bank credit becomes monotonically decreasing in the number of competitors.

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Keywords: number of competitors; collateralized bank financing; resale of productive assets; outside firms.

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1 Introduction

Startup firms and small enterprises crucially rely on external financing, especially bank credit, to install capacity and begin production and/or to undertake new risky investments (e.g., Beck and Demirguc-Kunt, 2006, Rajan and Zingales, 1998). Credit conditions for firms depend on several factors, such as the macroeconomic environment and credit market structure. In this theoretical paper, we focus on a specific factor, that is, product market competition (PMC) and investigate how it affects the equilibrium amount of bank credit available to firms.

Most of the literature points to the negative effect of PMC on credit (for empirical evidence on big companies, see, e.g., Valta, 2012, Xu, 2012, Frésard and Valta, 2016). The theoretical intuition is that competitive pressure shrinks firms' expected profits and the income that can be pledged to lenders; in turn, this reduces the amount of credit firms can access (Holmstrom and Tirole 1997).

Yet, firms can put up productive assets (PAs) as collateral to enhance their borrowing capacity. As a consequence, not only firms' profitability but also the value of their collateralized PAs is a crucial determinant of credit availability. Indeed, firms may default, in which case lenders recover part of their capital by seizing and selling collateralized PAs (for empirical evidence on the positive relationship between collateralized PAs' liquidation value and credit conditions, see, e.g., Gan, 2007, and Chaney et al., 2012). The recent financial crisis pointed to the relevance of the collateral channel for startup firms' and small enterprises' access to credit (e.g., European Commission, 2014, and Giovannini et al., 2015).

Interestingly, PMC, as measured by the number of competitors in a specific market, matters for the liquidation value of collateralized PAs, especially when assets are industry-specific. Direct competitors are indeed the second best users of PAs, hence they are willing to bid the most for them. In a seminal contribution, Shleifer and Vishny (1992) argue that the resale value of collateralized PAs is affected by the state of health of competitors (for evidence on the fact that PAs of distressed firms are mostly valuable for direct competitors, see, e.g., Acharya et al., 2007, Habib and Johnsen, 1999, Ortiz-Molina and Phillips, 2014, and Gavazza, 2010).

This paper aims to fill a gap in the literature by showing that less concentrated industries provide a larger pool of potential buyers of industry-specific PAs than highly concentrated industries and can thus enhance their liquidation value; the resulting positive effect of PMC on credit through the collateral channel, indeed, received scant attention. More precisely, we propose a framework where PMC influences both firms' profitability and the PAs' resale value to investigate the effect of this twofold mechanism on the equilibrium amount of bank credit.

In a model where firms demand bank credit to install production capacity and then compete à la Cournot, we introduce an exogenous idiosyncratic probability of default. A key premise of our framework is that banks can anticipate the negative outcome before Cournot competition takes place.[1] In this case, banks seize the collateralized PAs of distressed firms and sell them in the secondary market, where healthy competitors (i.e., those who are not hit by the shock) are the only potential buyers.[2]

Our main findings are as follows. There are conditions under which an inverted U-shaped relationship occurs between the equilibrium amount of bank credit and the number of rivals in the Cournot oligopoly. The intuition rests on the following trade-off. On one hand, the number of competitors positively affects the expected resale value of PAs, thus enhancing the income that can be pledged to banks. This is because the PAs of a failing firm are valuable only if there are healthy rivals willing to make an offer for them. The probability of such a favorable event increases along with the number of competitors. On the other hand, such number negatively affects the equilibrium price and the firms' profits, therefore shrinking the equilibrium credit.

An important extension of the model considers firms that produce similar goods outside the relevant market. These firms, referred to as outsiders, are willing to purchase PAs in liquidation and enter the market by replacing distressed incumbents. The existence of outsiders in competition with healthy incumbents to acquire the PAs enhances their resale value. At equilibrium, the amount of bank credit available to incumbents is larger than in the case without outsiders, but it becomes monotonically decreasing in the number of incumbent firms.

Overall, our contribution is twofold. First, we highlight a previously overlooked positive effect of PMC on bank credit through the collateral channel. Second, we show that the way this collateral channel works is crucially affected by the existence of outsiders. Our results find some support in the empirical literature, which is extensively discussed in Section 6; more importantly, they are relevant for startup firms' and small enterprises' access to credit and their ability to invest. In particular, the model points to the importance of enhancing

[1] As argued by, e.g., Rajan (1992), banks are more likely to be informed about the future outcome of productive projects than other "arm's-length" creditors, such as bondholders.

[2] An important aspect of the idiosyncratic shock is that the distressed firms' PAs do not lose their value and can thus be sold in the secondary market. In other words, we disregard shocks such as burning or flood of the productive sites.

the liquidity of collateralized PAs for firms that mostly rely on bank credit.

Related theoretical literature. The research question of this paper was inspired by Shleifer and Vishny (1992). In their work, as mentioned, PAs are mostly valuable for competitors in the same industry; as a result, credit-constrained firms can increase their debt capacity when direct rivals are in a position to make an offer for the assets.

There exists a strand of theoretical literature, which relates credit availability to PMC; in particular, the impact of external financing on firms' competitive behavior in the product market is investigated (e.g., Brander and Lewis, 1986, and the survey by Cestone, 1999). Our focus is instead on the reverse causality, in particular, on the impact of PMC on bank financing through the collateral channel. To the best of our knowledge, the only theoretical paper where this feedback is explored is Cerasi and Fedele (2011), who consider asymmetric information between firms and lenders and focus on a duopoly without outsiders. Salgado et al. (2016) and Almeida et al. (2011) are also related to our paper. Salgado et al. (2016) introduce a duopoly setting, where firms experience a common negative shock, to explore the impact of market structure on the liquidation value of assets, rather than on bank financing. In particular, they study the optimal timing at which collateralized PAs should be sold to avoid misallocation. Almeida et al. (2011) develop a model with liquidity shocks similar to those in this paper in order to study the availability of credit lines for firms with industry-specific PAs; however, they do not investigate PMC.

The rest of the paper is as follows. Section 2 describes the setup of the model, while Section 3 computes the equilibrium credit. Section 4 provide some comparative statics on the equilibrium results. Section 5 extends the analysis to outsiders. Section 6 discusses the main assumptions of the theoretical framework, while Section 7 reviews the related empirical literature. Section 8 concludes the paper. Proofs are in the appendix.

2 Setup

Consider an industry with $N \in [2, \infty)$ ex-ante symmetric risk-neutral firms and three dates $t = \{0, 1/2, 1\}$. At date 0, each firm $i = \{1, ..., N\}$ builds production capacity by investing the amount cq_i, where q_i denotes the capacity level and $c > 0$ the unit capacity cost. Firm i will be active in the product market at the future date 1 with probability $p \in (0, 1]$, in which case the firm will produce a homogeneous good and will make positive profits; by contrast, firm i will be hit by a negative idiosyncratic shock with probability $(1 - p)$, in which case it will not be active in the product market at date 1 and its profits will be zero. Probabilities

$t = 0$	$t = \frac{1}{2}$	$t = 1$
Each firm i borrows $B_i = cq_i$ to invest in capacity. All firms set their capacity non-cooperatively and simultaneously.	Banks receive perfect signals about i.i.d. shocks. PAs are traded in second-hand market, where healthy firms simultaneously decide how many PAs to acquire.	Healthy firms compete à la Cournot with capacity constraints. Loans are repaid.

p are i.i.d. across firms. The probability distribution of firms' shocks is common knowledge. Firm i is cashless, hence the amount $B_i = cq_i$ to finance the investment in capacity at date 0 is borrowed from a risk-neutral bank. The loan agreement is a collateralized debt contract; the collateral consists of firm i's PAs, i.e., the assets bought to install capacity q_i. We denote with $r_i > 0$ the amount firm i commits to repay to bank i at date 1; due to limited liability, firm i repays r_i only if it is not hit by the shock.

At an interim date 1/2, each bank i receives a perfect signal about the future realization of firm i's profits. If the signal is negative - this occurs with probability $(1 - p)$ - bank i anticipates that firm i will not be able to repay the debt at date 1 because of the lack of cash flow; bank i then seizes the PAs of the defaulted borrower, sells them in the second-hand market, and cashes their liquidation value; this mechanism is common knowledge. Healthy rivals, i.e., those not hit by the shock, are the only potential buyers of PAs. Since healthy firms are cashless, they are granted additional funds from their banks to purchase the PAs of failing rivals. Accordingly, the equilibrium repayment r_i will be computed by taking into account also the potential extra funds granted by bank i at $t = 1/2$ in case firm i is healthy.

At date 1, healthy firms compete à la Cournot in the product market, the unit production cost being 0, and repay the debt; this Cournot quantity cannot exceed firm's total capacity level, given by the capacity installed at date 0 plus the possible additional capacity given by the purchase of PAs from failing rivals at date 1/2. The inverse demand function for the homogeneous good supplied by healthy firms is given by $P = S - bQ$, where S denotes the consumers' maximum willingness to pay, with $S > c$, and b measures the effect of total industry output Q on price P.

Before proceeding, we depict the complete timing of the three-stage capacity-constrained quantity competition game played by firms and banks.

We introduce the following assumption:

Assumption 1 $c \in \left[\frac{S}{2}, S\right)$.

Assumption 1 states that the unit capacity cost c is relatively high; doing so, it restricts the set of equilibria of the three-stage game and simplifies the analysis. In particular, as it will become clear later on, the equilibrium capacity set by firms at date 0 will be relatively small due to high c; as a result, all healthy firms will find it profitable to make an offer for all the PAs on sale at date 1/2, in order to increase the limited capacity installed at date 0, and they will produce at full capacity at date 1. For the sake of completeness, in Section 5 we relax Assumption 1, study a simplified version of the three-stage game for any $c \in (0, S)$, and show that our results are not qualitatively affected.

3 Equilibrium

We compute the equilibrium of the three-stage game restricting on pure-strategy subgame perfect Nash equilibria (SPNEs). As mentioned, Assumption 1 drives the outcomes of the second and third stages. In particular, Cournot competition at date 1 has a trivial solution because healthy firms simply produce at full capacity, whose equilibrium level is given by the solution to the first and second stage, and, at date 1/2, all healthy firms are willing to make an offer for all the PAs on sale. Accordingly, we first compute the second-stage equilibrium offers by healthy firms; we then, by backward induction, calculate the first-stage equilibrium capacity level and the resulting amount of credit granted by banks.

The equilibrium offers for the failing firms' PAs are computed under the assumption that in case of a tie in the healthy firms' simultaneous offers, indivisible PAs are randomly assigned to a single firm who pays the offered price. Three alternative scenarios must be investigated separately, depending on the number of healthy firms at date 1/2, which we denote by H.

(i) When $H \in [2, N-1]$ firms are healthy at date 1/2, we rely on a Bertrand argument to state that the equilibrium offer for any single failing firm's PAs coincides with the maximum amount of money healthy firms are willing to pay. This amount is defined as the reservation value and it is given by the extra-revenue any healthy firm gains when acquiring the additional production capacity of failing rival's PAs. In symbols,

$$P_N 2q^* - P_N q^* \left(= P_N q^*\right), \tag{1}$$

where q^* denotes the equilibrium symmetric capacity level set by all firms at date 0 and $P_N = S - bNq^*$ indicates the price of the homogeneous good when the PAs of all N firms remain productive given that all failing firms' PAs are acquired by healthy rivals. Expression (1) is the difference between the revenue made by any healthy firm when it acquires a failing rival's PAs and then produces at full capacity $q^* + q^* = 2q^*$, and the revenue when no acquisition occurs, the production being therefore q^*. Since (1) is the same for all $H \in [2, N-1]$ healthy firms, there will be a tie in the equilibrium offers, with the effect that any healthy firm gets the PAs with probability $\frac{1}{H}$. Note that the capacity cost cq^* does not enter in (1) because it is sunk at date 1/2.

(ii) When only one firm is healthy at date 1/2, $H = 1$, the equilibrium offer for the PAs of each of the $(N-1)$ rivals is equal to ε, where ε is an arbitrarily small positive amount. This infinitesimal amount is the winning offer when only one firm is willing to purchase PAs because, reasonably, this firm has full bargaining power.

(iii) Finally, when either all firms or none of them are healthy, $H = N$ or $H = 0$, there is no transfer of PAs.

3.1 Special Case with $N = 3$

For simplicity, we first calculate the equilibrium capacity in the special case where three firms are present at date 0. In the next subsection, we extend the result to the general oligopoly case with $N \geq 2$ firms.

We calculate the representative firm 1's and bank 1's expected profit functions at date 0. Denoting by q_1 the capacity level installed by firm 1 at date 0 and anticipating that $q^*(3)$ is the equilibrium capacity set by each rival at date 0, firm 1's profit function is

$$U_1 = p\left(P_3 q_1 - r_1\right) + p\left[2p\left(1-p\right)\frac{1}{2}P_3 q^*\left(3\right) + \left(1-p\right)^2 P_3 2q^*\left(3\right)\right] + \left(1-p\right)0. \qquad (2)$$

Expression (2) consists of three terms. First term: with probability p firm 1 is healthy at date 1, it produces at full capacity q_1 without additional production costs and earns $P_3 q_1$, where $P_3 = S - b\left[q_1 + 2q^*\left(3\right)\right]$ indicates the price of the homogeneous good when the total production is equal to the total capacity, $q_1 + 2q^*(3)$, regardless of the allocation of PAs among healthy firms; moreover, it repays r_1 to bank 1. Second term: when one rival, either firm 2 or firm 3, fails - probability $2p(1-p)$ - firm 1, along with the healthy rival, is willing to purchase the failing rival's PAs; it actually acquires them with probability $\frac{1}{2}$ and gets the extra-revenue $P_3 q^*(3)$; this value is obtained by substituting $N = 3$ and $q^*(3)$ into (1). When instead both rivals fail - probability $(1-p)^2$ - firm 1 is the only potential buyer of the two rivals' PAs, acquires them with probability 1, and gets the extra-revenue $P_3 2q^*(3)$. Third term: if firm 1 fails - probability $(1-p)$ - it earns nothing.

The expected profit function of bank 1, denoted by V_1, is as follows:

$$V_1 = p\left[r_1 - 2p(1-p)\frac{1}{2}P_3 q^*(3) - (1-p)^2 2\varepsilon\right] + (1-p)\left[p^2 P_3 q_1 + 2p(1-p)\varepsilon\right] - cq_1. \quad (3)$$

Expression (3) consists of three terms. First term: when firm 1 is successful - probability p - bank 1 pockets r_1. Moreover, when only one rival fails - probability $2p(1-p)$ - bank 1 lends an expected extra amount $\frac{1}{2}P_3 q^*(3)$ to firm 1, which offers $P_3 q^*(3)$ to buy the PAs of the failing rival, $\frac{1}{2}$ being the probability that firm 1 obtains the PAs on sale and actually pays the offered price. When the two rivals default - probability $(1-p)^2$ - bank 1 funds the amount 2ε offered by firm 1 to acquire the PAs of both rivals. Second term: firm 1 fails with probability $1-p$; when both rivals are healthy - probability p^2 - bank 1 sells firm 1's PAs at price $P_3 q_1$, which is offered by both competing buyers; with probability $2p(1-p)$ only one rival, either 2 or 3, is healthy and buys at price ε because it has full bargaining power. Finally, we set the risk-free rate to be zero, so that the last term, $-cq_1$, denotes the opportunity cost of the amount lent to firm 1. Before proceeding, it is worth noting that the expected extra credit granted by bank 1 when firm 1 is the only healthy one, $-p(1-p)^2 2\varepsilon$, cancels with the expected value recovered from the sale of firm 1's PAs in case only one rival is healthy, $2(1-p)^2 p\varepsilon$.

To compute the expected repayment pr_1 owed by firm 1 to bank 1, we suppose that bank 1 operates on a break-even basis; in symbols, $V_1 = 0$. We then solve $V_1 = 0$ by pr_1:

$$pr_1 = cq_1 + p^2(1-p)P_3 q^*(3) - (1-p)p^2 P_3 q_1. \quad (4)$$

The expected repayment pr_1 required by bank 1 to break even increases with the opportunity cost of lending, cq_1, and with the expected extra-credit disbursed to firm 1 when the firm, along with an healthy rival, is willing to buy the failing rivals' PAs, $p^2(1-p)P_3 q^*(3)$. On the contrary, pr_1 decreases with the expected value recovered by bank 1 from the sale of firm 1's PAs when the two rivals are healthy, $(1-p)p^2 P_3 q_1$.

Plugging (4) into (2) gives firm 1's expected profits at date 0,

$$U_1 = p\left[P_3 q_1 + (1-p)^2 P_3 2q^*(3)\right] + (1-p)p^2 P_3 q_1 - cq_1. \quad (5)$$

Expression (5) can be read as follows. With probability p, firm 1 is successful and earns $P_3 q_1$. It gains the extra revenue $P_3 2q^*(3)$ when it is the only buyer of both rivals' PAs - probability $p(1-p)^2$ - and produces at the additional capacity $2q^*(3)$. This purchase is costless in expected terms for bank 1 and, thanks to the bank's break-even condition, for firm 1; the aforementioned reason is that the expected extra credit granted by bank 1, $-p(1-p)^2 2\varepsilon$, cancels with the expected value recovered from the sale of firm 1's PAs when just one rival is healthy, $2(1-p)^2 p\varepsilon$. By contrast, with probability $(1-p)$ firm 1 fails and makes no profit; yet, according to (4), the expected repayment pr_1 required by bank 1 to break even is reduced by the resale value of firm 1's PAs, $P_3 q_1$, offered by both rivals when they are healthy - probability p^2. The last term, cq_1, is the capacity cost.

At date 0, firm 1 chooses q_1 to maximize (5), given that each rival sets the equilibrium capacity at $q^*(3)$. Taking into account a non-negativity constraint, this yields the symmetric capacity set by each firm at the equilibrium of our three-stage game,

$$q^*(3) = \max\left\{0, \frac{\left[p + (1-p)p^2\right]S - c}{2bp(3-p^2)}\right\} \tag{6}$$

and the resulting amount of credit granted by banks, $B^*(3) = cq^*(3)$:

$$B^*(3) = \max\left\{0, \frac{c\left[p + (1-p)p^2\right]S - c^2}{2bp(3-p^2)}\right\}. \tag{7}$$

3.2 General Case

In this subsection, we study the general case with $N \in [2, \infty)$ firms at date 0 and compute the equilibrium capacity. Similarly to the previous case with $N = 3$, firm i chooses q_i in order to maximize its expected profit function U_i provided that bank i breaks even, i.e., $V_i = 0$. Recalling that q^* denotes the equilibrium capacity installed by all other rivals, in Appendix A.1 we derive the following expression for firm i's expected profits:

$$\begin{aligned} U_i = p\left[P_N q_i + (1-p)^{N-1} P_N (N-1) q^*\right] + \\ (1-p)\left[1 - (1-p)^{N-1} - (N-1)p(1-p)^{N-2}\right] P_N q_i - cq_i, \end{aligned} \tag{8}$$

where q_i is the capacity installed by firm i.

Formula (8) is to be interpreted similarly to (5). With probability p firm i is successful and earns $P_N q_i$, with $P_N = S - b\left[q_i + (N-1)q^*\right]$ indicating the price of the homogeneous good when the total production is equal to the total capacity, $q_i + (N-1)q^*$. The extra-revenue $P_N(N-1)q^*$ accrues to firm i when it is the only buyer of all rivals' PAs - this occurs with probability $p(1-p)^{N-1}$ - acquires them at zero expected cost, and produces at the additional capacity $(N-1)q^*$. Instead, with probability $(1-p)$ firm i fails and makes zero profit. However, if at least two rivals are healthy - this occurs with probability $\left[1 - (1-p)^{N-1} - (N-1)p(1-p)^{N-2}\right]$ - bank i anticipates it will cash the equilibrium offer $P_N q_i$ paid by a healthy rival to acquire the PAs of firm i. As a result, the expected repayment pr_i required by bank i to break even is reduced by the amount $P_N q_i$. The last term, cq_i, denotes the cost of installing the capacity q_i.

At date 0, firm i chooses q_i to maximize (8) given that q^* is the equilibrium capacity set by each rival. This yields

$$q^* = \max\left\{0, \frac{S\left\{1-(1-p)^{N-1}\left[1+p\left(N-2\right)\right]\right\}-c}{b\left\{(N+1)-(1-p)^{N-1}\left[N+1+p\left(N-1\right)^2-2p\right]\right\}}\right\} \tag{9}$$

and the resulting equilibrium amount of credit granted by banks, $B^* = cq^*$, reported in the following

Proposition 1 *The symmetric equilibrium amount of credit granted by banks at date* 0 *is*

$$B^* = \max\left\{0, \frac{cS\left\{1-(1-p)^{N-1}\left[1+p\left(N-2\right)\right]\right\}-c^2}{b\left\{(N+1)-(1-p)^{N-1}\left[N+1+p\left(N-1\right)^2-2p\right]\right\}}\right\}. \tag{10}$$

Proof. In Appendix A.1. ■

4 Comparative Statics

We discuss how the equilibrium credit B^*, calculated in Proposition 1, varies with the number of active firms N at date 0 and the success probability p. Given the complicated formula of B^*, we resort to numerical examples, while we develop a more general analysis in Appendix A.1. Without loss of generality, we can fix both parameters S and b to 1.

In Figure 1, we let $c = 0.7$ to fulfill Assumption 1 and draw the equilibrium credit B^* in space (p, N, q^*).

Figure 1 here

Figure 1 shows that: (i) B^* is zero when p tends to zero; (ii) B^* is zero for $p \leq 0.7$ when N tends to 2; (iii) B^* is positive for any $N \geq 2$ when $p \geq 0.7$; (iv) provided that p is not close to 1, there is an inverted U-shaped relation between B^*, when positive, and N; (v) B^* is monotonically decreasing in N when p is close to 1.

The above findings can be explained as follows.

(i) The equilibrium credit B^* is zero when p tends to zero, i.e., when it is likely that all firms will fail, because the representative firm i's expected profits (8) become negative, hence firm i neither invests in capacity nor borrows money.

(ii) Similarly, B^* is zero when N tends to 2 and p is relatively small ($p \leq 0.7$ in Figure 1). The intuition is as follows. Suppose $N = 2$ and denote with $q^*(2)$ the resulting equilibrium capacity; firm is' expected profits (8) become

$$U_i = p\left[P_2 q_i + (1-p) P_2 q^*(2)\right] + (1-p)\,0 - cq_i. \tag{11}$$

When firm i fails - with probability $(1-p)$ - bank i is not able to recover any positive value from the sale of PAs because there are no rival firms that compete to get them. Such a negative scenario, where there is no reduction of the expected repayment pr_i required by bank i to break even, is more likely to occur as p becomes smaller and smaller. This is why firm i does not borrow money when N tends to 2 and p is relatively low.

(iii) For all other values of p and N, B^* is instead positive; in particular, B^* is initially increasing and then decreasing in N, provided that p is not too close to 1. This result is driven by two opposite forces. On the one hand, the equilibrium price $P_N = S - bNq^*$ is negatively affected by N. This is the standard negative effect on the firms' profits and, in turn, on q^* and B^* as the number of competitors rises. On the other hand, a potential positive effect arises as the probability of default is taken into account.

To illustrate such positive effect, we consider the two lowest values $N = 2$ and $N = 3$. Firm i s' expected profits are given by (11) when $N = 2$ and by (5) when $N = 3$. Comparing these two expressions, one can remark that in case firm i is failing - with probability $(1-p)$ - a positive liquidation value for PAs, $P_3 q_i$, may be recovered only when $N = 3$ provided that both rivals are healthy - with probability p^2. Put differently, the second-hand PAs of a failing firm are valuable only if at least two rivals are healthy and compete to buy them. Because the probability of such a favorable event is positively affected by N, an increasing number of active competitors at date 0 positively impacts on the PAs' expected liquidation value, augments firms' expected profits and, in turn, enhances B^*.

However, the above positive effect vanishes when a very large number of competitors are active at date 0. The reason is that the PAs' liquidation value, $P_N q_i$, tends to zero if $N \to \infty$ because P_N is decreasing in N. This is why the equilibrium credit B^* becomes decreasing in N as $N \to \infty$

(iv) Finally, B^* is monotonically decreasing in N when p tends to 1. When it is very likely that all firms are healthy, almost no trade of second-hand PAs occurs: this means that there is no liquidation value of PAs and, in turn, no positive effect of PMC on firms' profits. Indeed, firm i's expected profits (8) become approximately $U_i = P_N q_i - cq_i$. This value is decreasing in N because the equilibrium price $P_N = S - bNq^*$ is negatively affected by N. As a result, q^* and B^* are decreasing in N.

5 Extensions

We investigate here two extensions of the baseline model. In Subsection 5.1, we relax the hypothesis that only healthy rivals can purchase PAs of distressed firms by also considering outside firms as potential buyers. In Subsection 5.2, we relax Assumption 1 and solve a simplified version of the three-stage game described in Section 2 for any $c \in (0, S)$.

5.1 Entry through Acquisition: the Role of Outsiders

Suppose there are at least two symmetric risk-neutral firms, referred to as outsiders, producing the same good as the healthy incumbents, or a similar one, but active in a different relevant market. Assume that at date 1/2, at least two of these firms are willing to acquire the second-hand PAs from distressed incumbents to be able to enter the incumbents' market. We denote with E the entry cost borne by outsiders to acquire the PAs of each failing incumbent firm.

Consistently with the previous analysis, we assume that outsiders make an offer for all the PAs on sale. For simplicity and without loss of generality, we also suppose that outsiders can afford to pay both the resale price of PAs and the entry cost.

We study how the presence of outsiders affects the trade of PAs by computing the equilibrium offers for each failing firm's PAs; as in the case without outsiders, we analyze three alternative scenarios, depending on the number H of healthy incumbents at date 1/2.

(i) When $H \in [2, N-1]$ incumbents are healthy, their offer for a single failing firm's PAs is $P_N\hat{q}$. This value is taken from (1), with $P_N = S - bN\hat{q}$, $\hat{q}$ denoting the symmetric equilibrium capacity set by the incumbent firms at date 0 when the potential entry of outsiders is taken into account. The outsiders' reservation value, $P_N\hat{q} - E$, is instead negatively affected by the entry cost E. Since this value is lower than the price offered by incumbents, the PAs on sale are assigned to an incumbent firm at the unit equilibrium price $P_N\hat{q}$.

(ii) When only one incumbent is healthy, $H = 1$, we rely on the Bertrand argument to assume that this incumbent outbids by ε the outsiders' reservation value, therefore getting the PAs on sale at the unit equilibrium offer $P_N\hat{q} - E + \varepsilon$.

(iii) Finally, when all incumbent firms are healthy, $H = N$, there is no trade of PAs; more interestingly, when all incumbents fail, $H = 0$, only outsiders are in the position to buy PAs; since they are competing for the PAs, the equilibrium offer for each asset is given by their reservation value, $P_N\hat{q} - E$.

A crucial difference arises compared to the case without outsiders. Banks recover a positive liquidation value for their distressed clients' PAs under any possible scenario, i.e., even when all incumbent firms are in distress, $H = 0$, because there are outsiders that compete to buy them. This affects firm i's expected profit function, which becomes

$$U_{i,O} = P_N q_i - (1-p)^N E - cq_i : \tag{12}$$

see Appendix A.2 for computations. Revenue $P_N q_i$, with $P_N = S - b\left[q_i + (N-1)\hat{q}\right]$ denoting the price of the homogeneous good when the total production is equal to the total capacity, $q_i + (N-1)\hat{q}$, is obtained with certainty by firm i, either directly when firm i is healthy, or indirectly through a reduction on the expected repayment required by bank i to break even. Indeed, bank i anticipates that it will cash the equilibrium offer $P_N q_i$ paid by a healthy incumbent or, when all incumbents are failing - probability $(1-p)^N$ - the equilibrium offer $P_N q_i - E$ paid by an outsider.

At date 0, firm i chooses q_i to maximize (12) given that $\hat{q}$ is the equilibrium capacity set by rival incumbents; this yields $\hat{q}$ and the equilibrium amount of credit granted by banks, $\hat{B} = c\hat{q}$, reported in the following

Proposition 2 *When at least two outsiders are willing to purchase the failing (incumbent) firms' productive assets, the symmetric equilibrium amount of credit granted by banks is*

$$\hat{B} = \frac{cS - c^2}{b(N+1)}. \tag{13}$$

Proof. In Appendix A.2. ■

Expression (13) is equivalent to (10) after substituting $p = 1$. This means that the equilibrium capacity ultimately reduces to the standard Cournot value when there are at least two outsiders willing to make an offer for the PAs of the failing incumbent firms; as a result, $\hat{B}$ is monotonically decreasing in N. To provide a graphical representation of $\hat{B}$, it is sufficient to set $p = 1$ in Figure 1. Unlike the case without outsiders, $\hat{B}$ is positive for any p, which implies that incumbent firms invest in capacity even if the success probability p is small.

Interestingly, the potential favorable effect of an increasing number of rivals at date 0 on the PAs' liquidation value and, in turn, on firms' profits disappears. The intuition is as follows. As explained in Section 4, such a favorable effect lies in the fact that the PAs of failing firms are valuable only when at least two rivals are healthy, the probability of which is positively affected by N. Put differently, a greater number of competitors at date 0 reduces the risk that banks do not recover a positive value for the collateralized PAs of their failing clients. This risk disappears here because there are outsiders that make an offer for PAs even if none of the incumbents are healthy. As a result, only the standard negative effect of a larger number of rivals on the equilibrium price and, in turn, on the equilibrium capacity and credit, is at work.[3]

To conclude this section, we provide a comparison between the equilibrium credit without outsiders, B^*, and the corresponding value when outsiders are present, $\hat{B}$.

Proposition 3 *The equilibrium credit is lower when no outsiders are willing to purchase PAs. In symbols, $B^* < \hat{B}$.*

Proof. In Appendix A.3. ■

The existence of outsiders enhances the liquidity of distressed incumbents' PAs by increasing the number of states in which the resale value is positive. As a result, the equilibrium credit increases compared to the case without outsiders.

5.2 Capacity-constrained Quantity Competition Game

We now relax Assumption 1 and investigate, for any $c \in (0, S)$, the pure-strategy SPNEs of the three-stage capacity-constrained quantity competition game described in Section 2. For the sake of simplicity, we focus on two specific market structures, namely duopoly ($N = 2$), and triopoly ($N = 3$), and then discuss the general oligopoly case, $N \geq 2$.

The main features of the SPNEs are described by separately considering two scenarios:[4] (i) relatively high values of c (i.e., $c \in \left(\frac{p^2 S}{4}, S\right]$ if $N = 2$ and $c \in \left(\frac{p^2(3-2p)S}{3}, S\right]$ if $N = 3$); (ii) relatively low values of c (i.e., $c \leq \frac{p^2 S}{4}$ if $N = 2$ and $c \leq \frac{p^2(3-2p)S}{3}$ if $N = 3$).

Scenario (i). In the first scenario, the SPNE is shown to be as in the baseline analysis. The intuition, anticipated in Section 2, is as follows. The equilibrium level of capacity is negatively affected by c (cfr. expressions (6) or (9)): when c is large, firms install relatively little capacity at date 0. As a consequence, at date 1/2, all healthy firms find it profitable to make an offer for all the PAs on sale in order to expand the limited capacity installed at date 0. At date 1, they compete à la Cournot by producing as much as they can, that is, at full capacity.

[3] For the sake of completeness, we briefly discuss the case where there is only one outsider. One can show that the equilibrium credit becomes

$$\max\left\{0, \frac{c\left[1-(1-p)^N\right]S - c^2}{b\left[2+(N-1)\right]\left[1-(1-p)^N\right]}\right\}. \qquad (a)$$

Similarly to B^*, computed in Proposition 1, there is an inverted U-shaped relation between (a) and N, provided that p is not close to 1.

[4] The complete proof is in Appendix B.

This result helps explain the role of Assumption 1 in our framework: Assumption 1 ensures that the two parametric conditions, which define Scenario (i) and yield the above described SPNE, are fulfilled not only for N equal to 2 or 3, but in general for any $N \geq 2$. To verify this claim, in Appendix C we show that Assumption 1 is a sufficient condition for all $H \in [1, N-1]$ healthy firms to be willing to make an offer for the all the PAs on sale, i.e. $N - H \in [1, N-1]$ at date 1/2, and to produce at full capacity at date 1.

Overall, the relatively little capacity installed at date 0 under scenario (i), or, more generally, under Assumption 1, induces (healthy) firms to strongly rely on the trade of second-hand PAs in order to increase their production capacity and to produce as much as they can in the third-stage Cournot competition. In other words, Assumption 1 gives particular emphasis to the role played by PAs' liquidation value in driving firms' investment decisions, and, in turn, credit conditions.

Scenario (ii). In the second scenario, Assumption 1 is not fulfilled because c is relatively low. The SPNE takes then the following different features. The first-stage equilibrium capacity is larger than in Scenario (i). At date 1/2, healthy firms find it profitable to make an offer not for all the PAs on sale, but just for either a fraction or none of them; the reason is that healthy firms installed enough capacity to produce the third-stage Cournot quantity. As a result, at date 1 healthy firms compete à la Cournot by holding excess capacity.

The above result shows that the equilibrium behavior of firms is different when Assumption 1 is relaxed. Nevertheless, our findings concerning the relationship between the equilibrium credit and the degree of PMC when outsiders are absent are not qualitatively affected. Indeed, the solution to the three-stage game for any $c \in (0, S)$, provided in Appendix B, confirms that the equilibrium credit can be either increasing or decreasing in $N = \{2, 3\}$ depending on the value of p: this is in line with the baseline results. Interestingly, when c tends to zero, the equilibrium credit is increasing in $N = \{2, 3\}$ for any p.

6 Discussion of the Theoretical Framework

In this section, we discuss some of the assumptions made in our model to simplify the analysis and to gain in terms of tractability.

More active or risk-averse banks? In the model, banks are assumed to operate on a break-even basis, to have no bargaining power, and to be risk-neutral.

Both the break-even and the zero bargaining power assumptions imply that firms' payoff is equivalent to the full surplus, (5) when $N = 3$ and (8) in the general case of $N \geq 2$. The alternative assumption is that firms and banks split the surplus according to some rule, e.g., a portion $\alpha \in [0, 1]$ of the surplus to firms and $(1 - \alpha)$ to banks; in this case, the proof in Appendix D shows that the equilibrium capacity (6) is not affected. This result can be easily extended to the case of $N \geq 2$.

The assumption of risk-neutral banks does not qualitatively affect our results because banks, in our framework, bear the minimum share of credit risk compatible with limited liability. More precisely, loans are not repaid only when the cash flow of firms, which are protected by limited liability, is zero and there is no resale of PAs. If banks were risk-averse, this risk allocation could not be manipulated in a more favorable way for them.

Bertrand competition in the second-hand market for PAs. In our model, firms are symmetric in their valuation of PAs since they supply a homogeneous product and have identical costs of setting their capacity. This implies perfect substitutability among buyers of second-hand PAs. In addition, buyers are not credit constrained at $t = 1/2$ because they receive extra lending by banks. Given that all buyers have the same reservation value and are not credit constrained, it is quite natural to consider Bertrand competition in the second-hand market for PAs. This implies that when at least two buyers are present, each buyer bids up to its reservation value.

Considering different types of competition (e.g., buyers bidding less than their reservation value) is harmless, as long as a positive liquidation value for PAs is recovered when at least two competitors are healthy. Indeed, the crucial driver of the inverted U-shaped relationship between the number of competitors and the equilibrium credit is the existence of a positive expected resale value of PAs.

Idiosyncratic versus common shocks. The assumption of idiosyncratic and independent shocks is made for analytical tractability. In the real world, however, competitors are exposed to correlated shocks, given by a combination of common and idiosyncratic factors. Interestingly, our results prove to be robust to the assumption of correlated shocks, provided that correlation is not 1. Indeed, the result that a larger number of incumbent firms increase the expected liquidation value of PAs and may enhance the investment in capacity can be obtained only if trade of PAs takes place. With perfectly positively correlated shocks, there is no trade because either all firms are healthy (i.e., no sellers) or failing (i.e., no buyers): the standard negative effect of competition on firms' profits and, in turn, on the investment in capacity prevails. By contrast, moving away from perfect correlation, there is the possibility that some rivals are in the position to bid for the PAs of distressed rivals. Accordingly, our results hold even when the assumption of independent shocks is relaxed provided that some degree of idiosyncraticity is retained (for a complete discussion of this issue in a framework similar to ours but with asymmetric information, see Cerasi and Fedele, 2011).

7 Related Empirical Evidence

We discuss the existing empirical evidence related to the assumptions and implications of our theoretical model.

Following Shleifer and Vishny (1992), the model rests on the assumption that when PAs are specific to a particular industry, rivals within the same industry are the best potential users of the assets of distressed firms. As a result, credit-constrained firms could increase their debt capacity when direct rivals are in a position to bid for their PAs. The reasonableness of this hypothesis is indirectly supported by Almeida et al. (2011) who show that liquid firms are more likely to acquire distressed firms in industries in which assets are industry-specific, but transferable across firms; and that firms are more likely to use credit lines when such mergers are more frequent. Acharya et al. (2007) confirms that the recovery rate of defaulted firms' creditors is significantly lower when the industry of defaulted firms is in distress, while Gavazza (2010) shows the positive effects of lower trading frictions in PAs secondary markets on within-industry capital reallocation. Evidence of a positive relation between collateral liquidation value and loan-to-value ratio is provided by Benmelech and Bergman (2009) for the U.S. airline industry, while Gan (2007) shows that the loss of value in the collateral reduces the ability of firms to obtain bank lending. Benmelech et al. (2005) show that firms within the same residential area raise more debt when there are more potential buyers of their collateralized assets and Benmelech and Bergman (2011) prove that the deterioration of a company's financial conditions has a sizeable impact on the cost of debt of its rivals as a result of the loss of value of their collateral. MacKay and Phillips (2005) and more recently Rauh and Sufi (2012) provide evidence of the importance of rivals and the type of their productive assets to explain leverage for a panel of US firms. This evidence is consistent with the idea that the degree of liquidity of PAs has a positive effect on the amount of lending. More recently, Bustamante and Frésard (2016) provide evidence that rivals matter for individual investment behavior.

There are several recent empirical papers investigating how the structure of the product market affects the investment behavior and financial decisions of the firms, and their typical conclusions are that a higher degree of PMC has a negative impact on investments and credit conditions. Valta (2012) analyzes the terms of loan contracts and finds evidence of an increase in the cost of debt for firms operating in more competitive industries. Similarly, Huang and Lee (2013) find a positive effect of PMC on the probability of default, that in turn increases credit costs. Among the paper gauging the effect of an increase in PMC following trade liberalization on individual firms' behavior, Xu (2012) finds a negative effect on leverage through profitability, while Frésard and Valta (2016) find a negative effect on investment due to the greater threat of entry related to trade liberalization.

The predictions of our theoretical model are partially in contrast with the aforementioned literature. In fact, in our model when only incumbents are willing to bid for the PAs of the distressed firms, an increase in PMC may increase the amount of credit (see Proposition 1); whereas when outsiders are present this effect is negative (see Proposition 2). Using a sample of Italian SMEs that rely on bank credit to finance their investment, Cerasi et al. (2017) find evidence of a positive effect of PMC on credit and investment whenever only incumbent companies have potential interest to bid for the PAs, while no significant effects are estimated when outsiders are present. We read this result as first evidence of the usefulness of our model to describe the mechanisms at work in markets in which the greater competitive pressure comes from incumbents and not by the threat of entry on the part of outsiders.

8 Concluding Remarks

In this paper, we presented a model in which credit conditions are affected by the degree of PMC. To this end, we considered not only the standard negative effect of PMC on profits but also the impact on the resale value of PAs put up as collateral. Whenever such PAs are specific to a given production, having more competitors in the output market enhances the resale value thanks to a higher demand for the PAs in case of liquidation. As outcome of this trade-off, we found an inverted U-shaped relationship between the number of rivals and the equilibrium bank credit. Interestingly, the amount of bank credit was shown to monotonically decrease in PMC, when there are firms outside the industry willing to acquire the PAs of distressed incumbents.

The framework hinges upon a number of assumptions, whose role was discussed in Section 6. In addition to these hypotheses, it is worth noting that the probability of firms' default was supposed not to be affected by the degree of PMC. This might be restrictive as PMC can increase the likelihood of a default and therefore mitigate the positive effect of PMC through the collateral channel. We leave for future research the extension of the model to the case in which the probability of default depends on PMC.

As a final consideration, the liquidation of PAs was assumed to be costly for outsiders but not for healthy incumbents, hence, the transfer of PAs does not imply any deadweight loss. If we were to assume liquidation costs, similarly to Salgado et al. (2016), the equilibrium amount of bank credit would be reduced but the positive effect of PMC through the collateral channel would still be present.

A Proofs

A.1 Proof of Proposition 1

Firm i's expected profits at date 0, expression (8), is computed as follows. With probability $(1-p)$, firm i defaults and makes zero profits. With probability p, firm i gains $P_N q_i$ and repays r_i at date 1; in addition, it earns the following extra-revenue,

$$\sum_{H=0}^{N-1} \binom{N-1}{H} p^H (1-p)^{N-1-H} \frac{1}{H+1} P_N (N-1-H) q^* : \tag{A.1}$$

when H rivals are healthy (and $N-1-H$ rivals are in distress) - this occurs $\binom{N-1}{H}$ times, each one with probability $p^H (1-p)^{N-1-H}$ - firm i gets PAs of all distressed rivals with probability $\frac{1}{H+1}$. Summing up, firm i's expected profit is:

$$U_i = p (P_N q_i - r_i) + p \sum_{H=0}^{N-1} \binom{N-1}{H} p^H (1-p)^{N-1-H} \frac{1}{H+1} P_N (N-1-H) q^*. \tag{A.2}$$

To calculate the expected profits of bank i, we first rely on the argument developed in Section 3 to sum up the equilibrium offers for a single failing firm's PAs:

$$\begin{aligned} v_N(1,H) &= \begin{cases} 0 & \text{if } H = N-1, \\ P_N q^* & \text{if } H \in [1, N-2], \\ \varepsilon & \text{if } H = 0, \end{cases} \\ v_N(0,H) &= \begin{cases} P_N q_i & \text{if } H \in [2, N-1], \\ \varepsilon & \text{if } H = 1, \\ 0 & \text{if } H = 0. \end{cases} \end{aligned} \tag{A.3}$$

Notation $(1,H)$ indicates that firm i plus H firms are healthy, whilst $(0,H)$ that firm i is failing and H firms are healthy. With probability p, firm i is healthy, repays r_i but needs extra borrowing to make an offer for the distressed rivals' PAs at unit price $v_N(1,H)$. With probability $(1-p)$, firm i fails, hence the bank seizes PAs and recovers the liquidation value $v_N(0,H)$. Summing up, the expected profit of bank i is

$$\begin{aligned} V_i = p &\left[r_i - \sum_{H=0}^{N-1} \binom{N-1}{H} p^H (1-p)^{N-1-H} \frac{1}{H+1} (N-1-H) v_N(1,H) \right] \\ &+ (1-p) \left[\sum_{H=0}^{N-1} \binom{N-1}{H} p^H (1-p)^{N-1-H} v_N(0,H) \right] - c q_i, \end{aligned} \tag{A.4}$$

where the last term is the opportunity cost of the loan. Substituting the equilibrium offers (A.3), bank i's expected profits can be rewritten as:

$$V_i = p\left[r_i - \sum_{H=1}^{N-1}\binom{N-1}{H}p^H(1-p)^{N-1-H}\frac{1}{H+1}P_N(N-1-H)q^* - (1-p)^{N-1}(N-1)\varepsilon\right] + (1-p)\left[(N-1)p(1-p)^{N-2}\varepsilon + \sum_{H=2}^{N-1}\binom{N-1}{H}p^H(1-p)^{N-1-H}P_N q_i\right] - cq_i. \tag{A.5}$$

We solve $V_i = 0$ by pr_i and substitute the result into (A.2). This gives (8) in the text, after remarking that

$$\sum_{H=2}^{N-1}\binom{N-1}{H}p^H(1-p)^{N-1-H} = 1-(1-p)^{N-1}-(N-1)p(1-p)^{N-2} \tag{A.6}$$

according to the Binomial density formula. Maximizing (8) with respect to q_i, when all rivals set their capacity at the equilibrium level q^*, and taking into account the non-negativity constraint on the capacity level yields the result in the text.

To prove the existence of an inverted U-shaped relationship between B^* and N, it is sufficient to proceed in two steps: (i) showing that $\lim_{N\to\infty} B^* = 0$; (ii) proving that $B^*(3) > B^*(2) \geq 0 \Leftrightarrow p \in (p^*, p^{**})$, with $0 < p^* < \frac{c}{S} < p^{**} < 1$. To simplify the exposition, we disregard the non-negativity constraint on B^*; this does not affect the result.

(i) Consider separately numerator and denominator of B^*. On the one hand, the limit for N that goes to ∞ of the numerator of B^* can be written as

$$c\left[(S-c) - S\times\lim_{N\to\infty}(1-p)^{N-1}(Np-2p+1)\right], \tag{14}$$

where $\lim_{N\to\infty}(1-p)^{N-1}(Np-2p+1)$ can be rearranged as $\lim_{N\to\infty}\frac{(Np-2p+1)}{(1-p)^{1-N}}$. Applying L'Hôpital's rule to this limit yields $-\frac{p}{\ln(1-p)}\lim_{N\to\infty}(1-p)^{N-1} = 0$. It follows that (14) is equal to $c(S-c)$.

On the other hand, the limit for N that goes to ∞ of the denominator of B^* can be written as

$$b\left\{\lim_{N\to\infty}(N+1) - \lim_{N\to\infty}(1-p)^{N-1}\left[N+1+p(N-1)^2-2p\right]\right\}. \tag{15}$$

The limit of the first term $(N+1)$ is ∞; while the limit of the second term can be rearranged as

$$\lim_{N\to\infty}\frac{\left(N+1+p(N-1)^2-2p\right)}{(1-p)^{1-N}}. \tag{16}$$

Again we can apply L'Hôpital's rule twice to this limit, hence

$$\frac{2p}{(\ln(1-p))^2}\lim_{N\to\infty}(1-p)^{N-1} = 0. \tag{17}$$

It follows that (15) is equal to ∞.

In conclusion, the limit of the numerator for N that goes to ∞, converges to $c(S-c)$ as proven in (14), while the limit of the denominator, converges to ∞, as proven in (15). Thus the limit of B^* converges to zero.

(ii) $B^*(2) = \frac{c}{bp}\frac{pS-c}{4-p}$ is monotonically increasing in $p \in [0,1]$, since

$$\partial\left(\frac{c}{bp}\frac{pS-c}{4-p}\right)/\partial p = \frac{c\left(p^2S - 2cp + 4c\right)}{bp^2\left(4-p\right)^2} > 0; \tag{18}$$

negative when $p \to 0$, positive when $p = 1$, and zero at $p = \frac{c}{S}$.

Similarly, $B^*(3) = \frac{c}{bp}\frac{\left(p+(1-p)p^2\right)S-c}{2(3-p^2)}$ is monotonically increasing in $p \in [0,1]$ as

$$\partial\left(\frac{c}{bp}\frac{\left(p+(1-p)p^2\right)S-c}{2\left(3-p^2\right)}\right)/\partial p = \frac{c\left(1-p\right)\left[3c\left(1+p\right)+Sp^2\left(3-p\right)\right]}{2bp^2\left(3-p^2\right)^2} > 0, \tag{19}$$

negative when $p \to 0$, positive when $p = 1$, and zero at $p = p^*$, where p^* is the only solution to $p + (1-p)p^2 = \frac{c}{S}$. Since both p and $p + (1-p)p^2$ are monotonically increasing in $p \in (0,1)$ and $p + (1-p)p^2 > p$, we infer that $p^* \in \left(0, \frac{c}{S}\right)$ and that

$$B^*(3) > B^*(2) = 0 \Leftrightarrow p \in \left(p^*, \frac{c}{S}\right]. \tag{20}$$

When $p > \frac{c}{S}$, both $B^*(2)$ and $B^*(3)$ are positive. Moreover, $B^*(2) = \frac{S-c}{3} > \frac{S-c}{4} = B^*(3)$ at $p = 1$; this implies that

$$B^*(3) > B^*(2) > 0 \Leftrightarrow p \in \left(\frac{c}{S}, p^{**}\right), \tag{21}$$

where $p^{**} \in \left(\frac{c}{S}, 1\right)$ is the only solution to $B^*(2) = B^*(3)$; it also implies that $B^*(2) > B^*(3) > 0 \Leftrightarrow p \in (p^{**}, 1]$. The result follows from (20) and (21).

A.2 Proof of Proposition 2

The outsiders' equilibrium offers for each of the failing firm's PAs are

$$\begin{aligned} v_{N,O}(1,H) &= \begin{cases} 0 & \text{if } H = N-1, \\ P_N\hat{q} & \text{if } H \in [1, N-2], \\ P_N\hat{q} - E + \varepsilon & \text{if } H = 0 \end{cases} \\ v_{N,O}(0,H) &= \begin{cases} P_N\hat{q} & \text{if } H \in [2, N-1], \\ P_N\hat{q} - E + \varepsilon & \text{if } H = 1, \\ P_N\hat{q} - E & \text{if } H = 0, \end{cases} \end{aligned} \tag{A.7}$$

where subscript O stands for outsider, $(1,H)$ indicates that incumbent firm i plus H incumbent firms are healthy, whilst $(0,H)$ that incumbent firm i is failing and H incumbent firms are healthy. Firm i's expected profit is as in (A.2), with $\hat{q}$ instead of q^*. On the contrary, expected profit of bank i is given by (A.4), with $\hat{q}$ instead of q^* and $v_{N,O}$ instead of v_N:

$$\begin{aligned} V_{i,O} = p &\left[r_i - \sum_{H=1}^{N-1}\binom{N-1}{H}p^H\left(1-p\right)^{N-1-H}\frac{1}{H+1}\left(N-1-H\right)P_N\hat{q} + \right. \\ &\left. - \left(1-p\right)^{N-1}\left(P_N\hat{q} - E + \varepsilon\right)\right] + \\ + \left(1-p\right) &\left[\sum_{H=0}^{N-1}\binom{N-1}{H}p^H\left(1-p\right)^{N-1-H}P_Nq_i - \left(1-p\right)^{N-1}E + \right. \\ &\left. - \left(N-1\right)p\left(1-p\right)^{N-2}\left(E-\varepsilon\right)\right] - cq_i. \end{aligned}$$

Rearranging yields

$$V_{i,O} = p\left[r_i - \sum_{H=0}^{N-1}\binom{N-1}{H}p^H(1-p)^{N-1-H}\frac{1}{H+1}(N-1-H)P_N\hat{q}\right]$$
$$+(1-p)\left(\sum_{H=0}^{N-1}\binom{N-1}{H}p^H(1-p)^{N-1-H}P_Nq_i-(1-p)^{N-1}E\right)-cq_i$$

We solve $V_{i,O} = 0$ by pr_i and substitute the result into firm's i profit. This gives equation (12) in the text. Maximizing (12) with respect to q_i, when all rivals set their capacity at the equilibrium level $\hat{q}$, yields the result in the text.

A.3 Proof of Proposition 3

To prove that $B^* \leq \hat{B} \Leftrightarrow q^* < \hat{q}$, we first observe that $\hat{q} > 0$ for any p and N, hence $q^* < \hat{q}$ when $q^* = 0$. We then focus on positive values of q^* and remark that $q^* - \hat{q}$ can be rewritten as

$$q^* - \hat{q} = \tfrac{S-c}{b}\left\{\tfrac{1}{N+1-(1-p)^{N-1}\left[N+1+p(N-1)^2-2p\right]} - \tfrac{1}{N+1}\right\}$$
$$-\tfrac{S}{b}\tfrac{(1-p)^{N-1}[1+p(N-2)]}{N+1-(1-p)^{N-1}\left[N+1+p(N-1)^2-2p\right]}.$$

Being $S > 0$ and $b > 0$, we can multiply the above difference by $\frac{b}{S}$ without affecting its sign. We get

$$\tfrac{b}{S}(q^*-\hat{q}) = \tfrac{S-c}{S}\left(\tfrac{1}{(N+1)-(1-p)^{N-1}\left(N+1+p(N-1)^2-2p\right)} - \tfrac{1}{N+1}\right)$$
$$-\tfrac{(1-p)^{N-1}(1+p(N-2))}{\left((N+1)-(1-p)^{N-1}\left(N+1+p(N-1)^2-2p\right)\right)} \tag{A.8}$$

We then consider the difference (A.8) for $\frac{S-c}{S} \to 1$:

$$\tfrac{1}{(N+1)-(1-p)^{N-1}\left(N+1+p(N-1)^2-2p\right)} - \tfrac{1}{N+1}$$
$$-\tfrac{(1-p)^{N-1}(1+p(N-2))}{(N+1)-(1-p)^{N-1}\left(N+1+p(N-1)^2-2p\right)}. \tag{A.9}$$

Note that (A.9) > (A.8). Expression (A.9) can be rearranged as

$$\frac{p(N-1)(1-p)^N}{(N+1)\left\{(1-p)^N\left[N+1-p(1+2N-N^2)\right]-(N+1)(1-p)\right\}},$$

which is negative iff

$$(1-p)^{N-1}\left\{1-p+N\left[1+p(N-2)\right]\right\} < (N+1). \tag{A.10}$$

To see that inequality (A.10) is fulfilled, note that the LHS of (A.10) is decreasing in p, hence it reaches the maximum value of $N+1$ at $p = 0$ and recall that $p \in (0,1]$. This implies that $0 >$ (A.9) $>$ (A.8) and, in turn, that $q^* - \hat{q} = B^* - \hat{B}$ is strictly negative for any given admissible (p, N).

B Relaxing Assumption 1

N=2. When two firms are present at date 0 and $c \in (0, S)$, the SPNE is as follows. At date 0, the two firms borrow $B_C^*(2) = cq_C^*(2)$ to set the following symmetric capacity level:

$$q_C^*(2) = \begin{cases} \frac{p^2S-c}{3bp^2} \in \left[\frac{S}{4b}, \frac{S}{3b}\right) & \text{if } c \in \left(0, \frac{p^2S}{4}\right], \\ \max\left\{0, \frac{pS-c}{bp(4-p)}\right\} < \frac{S}{4b} & \text{if } c \in \left(\frac{p^2S}{4}, S\right], \end{cases} \tag{A.11}$$

where subscript C stands for Cournot; unsurprisingly, $q_C^*(2)$ is decreasing in c.

At date 1/2, there is only one healthy firm with probability $2p(1-p)$, in which case this firm, referred to as ex-post monopolist, buys the PAs of the only distressed rival at price ε.

At date 1, each healthy firm produces at full capacity $q_C^*(2)$ when both firms are healthy because such capacity is lower than the Cournot duopoly quantity with zero production costs, $\frac{S}{3b}$, for any $c > 0$. When only one firm is healthy, its capacity is equal to $2q_C^*(2)$; this value is higher than the monopoly quantity with zero production costs, $\frac{S}{2b}$, if $c \in \left(0, \frac{p^2S}{4}\right]$, in which case the firm produces $\frac{S}{2b}$ and holds excess capacity $\left(2q_C^*(2) - \frac{S}{2b}\right)$; $2q_C^*(2)$ is instead lower than $\frac{S}{2b}$ if $c \in \left(\frac{p^2S}{4}, S\right]$, in which case the firm produces at full capacity.

N=3. When three firms are present at date 0 and $c \in (0, S)$, the SPNE is as follows. At date 0, the three firms borrow $B_C^*(3) = cq_C^*(3)$ to set the following symmetric capacity level:

$$q_C^*(3) = \begin{cases} \frac{S}{3b} & \text{if } c \in \left(0, \frac{p^2(1-p)S}{3}\right], \\ \frac{p^2S(1-p)-c}{2bp^2(1-p)} \in \left[\frac{S}{4b}, \frac{S}{3b}\right) & \text{if } c \in \left(\frac{p^2(1-p)S}{3}, \frac{p^2(1-p)S}{2}\right], \\ \frac{p^2S-c}{2bp^2(1+p)} \in \left[\frac{S}{5b}, \frac{S}{4b}\right) & \text{if } c \in \left(\frac{p^2(1-p)S}{2}, \frac{p^2(3-2p)S}{5}\right], \\ \frac{p^2S(2-p)-c}{4bp^2(2-p)} \in \left[\frac{S}{6b}, \frac{S}{5b}\right) & \text{if } c \in \left(\frac{p^2(3-2p)S}{5}, \frac{p^2(3-2p)S}{3}\right], \\ \max\left\{0, \frac{pS(1+p-p^2)-c}{2bp(3-p^2)}\right\} < \frac{S}{6b} & \text{if } c \in \left(\frac{p^2(3-2p)S}{3}, S\right]. \end{cases} \tag{A.12}$$

At date 1/2, there are two healthy and one distressed firms with probability $3p^2(1-p)$; in this case, the two healthy firms, referred to as ex-post duopolists, are not willing to buy the failing rival's PAs if $c \in \left(0, \frac{p^2(1-p)S}{3}\right]$ because they installed enough capacity at date 0 to produce the Cournot duopoly quantity, $\frac{S}{3b}$; they are instead willing to offer their reservation value to get the PAs if $c \in \left(\frac{p^2(1-p)S}{3}, S\right]$ because the capacity installed at date 0 is lower than $\frac{S}{3b}$. With probability $3p(1-p)^2$, there are one healthy and two distressed firms; the ex-post monopolist buys the PAs of just one distressed rival at price ε if $c \in \left(0, \frac{p^2(1-p)S}{2}\right]$ because $2q_C^*(3)$ is enough to produce the monopoly quantity $\frac{S}{2b}$; the ex-post monopolist buys the PAs of both rivals at price 2ε if $c \in \left(\frac{p^2(1-p)S}{2}, S\right]$ because $2q_C^*(3)$ is not enough to produce the monopoly quantity.

At date 1: (i) when all firms are healthy, they produce the Cournot triopoly quantity $\frac{S}{4b}$ and hold excess capacity $\left(q_C^*(3) - \frac{S}{4b}\right)$ if $c \in \left(0, \frac{p^2(1-p)S}{2}\right]$, while they produce at full capacity $q_C^*(3)$ if $c \in \left(\frac{p^2(1-p)S}{2}, S\right]$; indeed, $q_C^*(3)$ is lower than $\frac{S}{4b}$ only in the latter interval of c. (ii) When two firms are healthy, they produce the Cournot duopoly quantity, $\frac{S}{3b}$, and hold excess capacity $\left(q_C^*(3) - \frac{S}{3b}\right)$ if $c \in \left(0, \frac{p^2(1-p)S}{3}\right]$; if c is higher, the healthy firms compete to get the PAs of the distressed rival: the firm that does not obtain them produces at full capacity $q_C^*(3)$; the other firm produces $\frac{S-bq_C^*(3)}{2b}$ and holds excess capacity $\left(2q_C^*(3) - \frac{S-bq_C^*(3)}{2b}\right)$ if $c \in \left(\frac{p^2(1-p)S}{3}, \frac{p^2(3-2p)S}{5}\right]$, while it produces at full capacity $2q_C^*(3)$ if $c \in \left(\frac{p^2(3-2p)S}{5}, S\right]$. (iii) Finally, when only one firm is healthy, it produces the monopoly quantity, $\frac{S}{2b}$, and holds excess capacity if $c \in \left(0, \frac{p^2S(3-2p)}{3}\right]$; the firm produces at full capacity, $3q_C^*(3)$, if $c \in \left(\frac{p^2S(3-2p)}{3}, S\right]$.

We discuss two results that are mentioned in the text

1) Under scenario (i), i.e., $c \in \left(\frac{p^2S}{4}, S\right]$ in (A.11) or $c \in \left(\frac{p^2(3-2p)S}{3}, S\right]$ in (A.12), the resulting equilibrium capacities, $q_C^*(2) < \frac{S}{4b}$ or $q_C^*(3) < \frac{S}{6b}$, are such that the ex-post monopolist is not able to produce the monopoly quantity even when buying the PAs of all distressed rivals. In this case, we showed that all healthy firms - the ex-post monopolist under $N = 2$ and both the ex-post monopolist and duopolists under $N = 3$ - find it profitable to buy all the PAs on sale at date 1/2 and to produce at full capacity at date 1. This is exactly the scenario studied in the baseline analysis for the general case of $N \geq 2$.

2) Comparing $B_C^*(2)$ with $B_C^*(3)$ for any given $c \in [0, S)$, one can check that the equilibrium credit can be either increasing or decreasing in N depending on the value of p unless c is particularly low, i.e., $c \in \left(0, \min\left\{\frac{p^2S}{4}, \frac{p^2(1-p)S}{3}\right\}\right]$. In this case, the resulting equilibrium credit is $c\frac{p^2S-c}{3bp^2} \in \left[\frac{cS}{4b}, \frac{cS}{3b}\right)$ when $N = 2$ and $\frac{cS}{3b}$when $N = 3$, with the former being weakly lower for any p.

C Making an offer for all the PAs on sale?

To show that Assumption 1 is a sufficient condition for all healthy firms to make an offer for all the PAs on sale, we consider a representative firm i at date 1/2 and suppose it is healthy. Two relevant cases where the transfer of PAs may occur must be analyzed separately: (i) either no rival is healthy, in which case firm i is referred to as the ex-post monopolist; (ii) or $H - 1 \in [1, N - 2]$ rivals are healthy.

(i) When firm i is the only potential buyer, it may buy the PAs of up to $N - 1$ failing rivals; if it makes an offer for the PAs of $n \in [0, N - 1]$ rivals, its third-stage revenue, net of its offers for the PAs on sale and in case it produces at full capacity, is $P_{n+1}(n + 1)q$, where $P_{n+1} = S - b(n + 1)q$ indicates the demand function when PAs of $n + 1$ firms stay in the market and q denotes the symmetric capacity set by firms at date 0. As $P_{n+1}(n + 1)q$ is increasing in n only if $q < \frac{S}{2b(n+1)}$, condition

$$q < \frac{S}{2bN} \tag{A.13}$$

is sufficient for firm i's revenue $P_{n+1}(n + 1)q$ to be increasing in n and therefore maximized at $n = N - 1$. Condition (A.13) implies that firm i cannot produce the third-stage monopoly quantity, $\frac{S}{2b}$, even when buying the PAs of all distressed rivals. As a result, firm i acquires all the PAs on sale and then produces at full capacity in order to reduce the gap from the profit-maximizing monopoly quantity, $\frac{S}{2b}$. Plugging q^* into (A.13) and rearranging yields the target parametric condition on c and ensures that $q^* < \frac{S}{2bN}$:

$$c > \frac{(N-1)\left\{1-p-(1-p)^N\left[1+p\left(N-1\right)\right]\right\}S}{2N\left(1-p\right)}. \tag{A.14}$$

(ii) When firm i plus $H-1 \in [1, N-2]$ rivals are healthy, $H \in [2, N-1]$ firms may be willing to buy PAs of up to $N-H \in [1, N-2]$ failing competitors. We first focus on $N=4$, so that H is either 2 or 3, and then move to the general case.

When $H=2$, two firms, say i and j, may buy the PAs of up to two rivals. Recalling that offers are simultaneous, the two firms play the following simultaneous symmetric game, where q denotes the equilibrium capacity with $N=4$:

firm j makes an offer for $\rightarrow$ firm i makes an offer for $\downarrow$	PAs of both failing rivals	PAs of one failing rival	No PAs
PAs of both failing rivals	$2P_4q; 2P_4q$	$\frac{5}{2}P_4q; \frac{3}{2}P_4q$	$3P_4q; P_4q$
PAs of one failing rival	$\frac{3}{2}P_4q; \frac{5}{2}P_4$	$\frac{3}{2}P_3q; \frac{3}{2}P_3q$	$2P_3q; P_3q$
No PAs	$P_4q; 3P_4q$	$P_3q; 2P_3q$	$P_2q; P_2q$

(A.15)

Payoffs are the firms' third-stage expected revenues, net of their offers for the PAs on sale, in case they produce at full capacity. The payoffs in the first cell are computed as follows. If both firms play "PAs of both failing rivals", they are willing to pay the same reservation value P_4q, derived from (1) with $N=4$, for each failing rival's PAs. Accordingly, there is a tie in the offers, in which case the ownership of the two PAs is randomly allocated to a single firm. The expected payoff for firm i is thus $\frac{1}{2}P_4 3q + \frac{1}{2}P_4 q = 2P_4 q$: $P_4 3q$ when it obtains the PAs of both failing competitors - this occurs with probability $\frac{1}{2}$; P_4q when it does not obtain the PAs - this occurs with probability $\frac{1}{2}$. Note that $P_4 = S - b4q$ indicates the price of the homogeneous good when the total production is equal to the total capacity, $4q$, regardless of the allocation of PAs among firms i and j. Consider now the payoffs in the second cell. Firm i plays "PAs of both failing rivals" and firm j plays "PAs of one failing rival"; firm i thus obtains with probability 1 the PAs which firm j is not making an offer for, while it gets the PAs of the other failing rival with probability $\frac{1}{2}$, since both players offer P_4q for them. Firm i gets $\frac{1}{2}P_4 3q + \frac{1}{2}P_4 2q = \frac{5}{2}P_4q$. Firm j instead gets $\frac{1}{2}P_4q + \frac{1}{2}P_4 2q = \frac{3}{2}P_4q$. Payoffs in the other cells are computed similarly. It is easy to check that "PAs of both failing rivals" is a dominant strategy when $P_{n+1}(n+1)q$ is increasing in n. Therefore, at the unique NE, the two firms make an offer to acquire all the PAs on sale (two) if (A.14) holds true.

When $H=3$, three firms may be willing to buy the PA of the only failing competitor. Again, one can check that condition (A.14) implies that the only NE is such that the three healthy firms make an offer for the single failing rival's PAs on sale.

One can generalize the analysis to $N \in [2, \infty)$ by considering the following game:

healthy rival makes an offer for $\rightarrow$ firm i makes an offer for $H-1 \in [1, N-2]$ $\downarrow$	PAs of $n \in [1, N-H]$ failing rivals	No PAs
PAs of $n \in [1, N-H]$ rivals	$\frac{1}{H} P_{H+n} (n+1) q + \left(1 - \frac{1}{H}\right) P_{H+n} q$	$P_{H+n} (n+1) q$
No PAs	$P_{H+n} q$	$P_H q$

(A.16)

Given the symmetry of payoffs, we write only firm i's payoffs in each cell; they are computed as follows. If all healthy firms play "PAs of n failing rivals", they are willing to pay the same reservation value $P_n q$ for each failing rival's PAs. Accordingly, there is a tie in the offers, in which case the ownership of n PAs is randomly allocated to a single firm. The expected payoff for firm i is thus: $P_{H+n} (n+1) q$ when it obtains the PAs - this occurs with probability $\frac{1}{H}$; $P_{H+n} q$ when it does not obtain the PAs - this occurs with probability $1 - \frac{1}{H}$. The other payoffs are computed similarly.

If $H-1$ healthy rivals play "PAs of n failing rivals", the best response of firm i is to play "PAs of n failing rivals" because $\frac{1}{H} P_{H+n} (n+1) q + \left(1 - \frac{1}{H}\right) P_{H+n} q > P_{H+n} q$. If $H-1$ healthy rivals play "no PAs", the best response of firm i is to play "PAs of n rivals" if $P_{H+n} (n+1) q > P_H q$. This inequality is implied by (A.14). To see this, note that $P_{H+n} (n+1) q > P_H q$ is implied by $P_{H+n+1} (n+2) q \geq P_{H+n} (n+1) q$ for any $n \in [0, N-H]$. In turn, the latter condition is equivalent to $\frac{n+2}{n+1} \geq \frac{P_{H+n}}{P_{H+n+1}}$. This inequality is fulfilled because $\frac{n+2}{n+1} > \frac{n+1+H}{n+H}$ is implied by $H \in [2, N-1]$ and $\frac{n+1+H}{n+H} \geq \frac{P_{n+H}}{P_{n+1+H}}$.by (A.14). As a result, when condition (A.14) holds true, the unique NE of the above game is such that all the healthy firms make an offer for the PAs of all failing rivals.

In conclusion, we remark that the RHS of (A.14) is monotonically increasing in N and $\lim_{N\to\infty} \frac{(N-1)\left\{1-p-(1-p)^N[1+p(N-1)]\right\} S}{2N(1-p)} = \frac{S}{2}$. The result follows.

D Relaxing the Banks' Break-even Assumption

Suppose $N = 3$ and that firm 1 and bank 1 split surplus S into two shares, αS to the firm and $(1-\alpha)S$ to the bank, where $\alpha \in [0, 1]$ and S is equivalent to (5). Equating the expected profit function of bank 1, (3), to $(1-\alpha)S$ yields the repayment to the bank as a function of α:

$$pr_1 = \alpha c q_1 + (1-\alpha) p P_3 q_1 + (1-\alpha) p (1-p)^2 P_3 2 q^*(3) - \alpha (1-p) p^2 P_3 q_1 + p^2 (1-p) P_3 q^*(3) \quad (22)$$

Substituting pr_1 from (22) into the expected profit function of firm 1, (2), we derive

$$\alpha \left\{ p \left[P_3 q_1 + (1-p)^2 P_3 2 q^*(3) \right] + (1-p) p^2 P_3 q_1 - c q_1 \right\} \quad (23)$$

Expression (23) is equivalent to (2), except for the multiplier α. When taking the derivative of (23) with respect to q_1, we obtain the equilibrium capacity (6).

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